

# Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/IL05/000199

International filing date: 17 February 2005 (17.02.2005)

Document type: Certified copy of priority document

Document details: Country/Office: US  
Number: 60/545,510  
Filing date: 19 February 2004 (19.02.2004)

Date of receipt at the International Bureau: 24 May 2005 (24.05.2005)

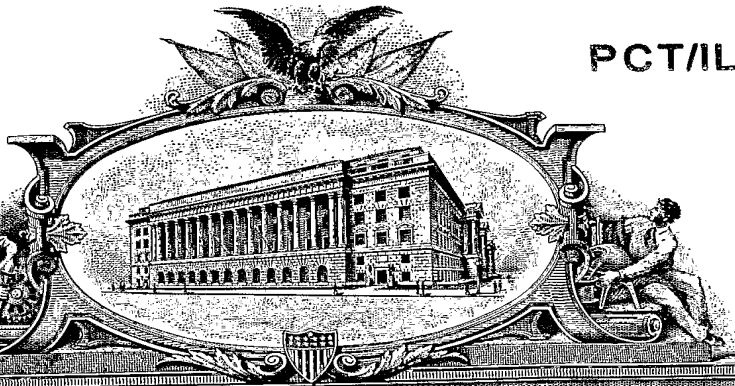
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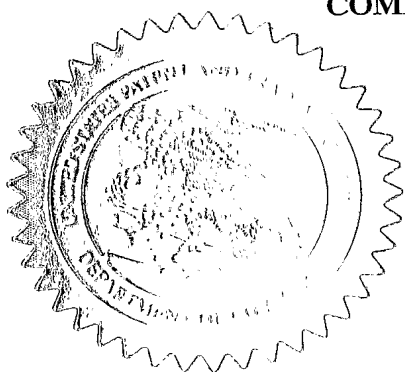
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APPLICATION NUMBER: 60/545,510  
FILING DATE: February 19, 2004

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16805 U.S. PTO

PTO/SB/16 (01-04)

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**PROVISIONAL APPLICATION FOR PATENT COVER SHEET**

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No.

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
1) Herve	BERCOVIER	Jerusalem, ISRAEL

Additional inventors are being named on the 2nd separately numbered sheets attached hereto

**TITLE OF THE INVENTION (500 characters max)**

**A PHARMACEUTICAL COMPOSITION AND METHOD FOR TREATING A DISEASE AND A DIAGNOSTIC TOOL THEREFOR**

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

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**ENCLOSED APPLICATION PARTS (check all that apply)**

- Specification Number of Pages 14
- CD(s), Number \_\_\_\_\_
- Drawing(s) Number of Sheets 3
- Other (specify) transmittal, postcard
- Application Data Sheet. See 37 CFR 1.76

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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

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[Page 1 of 2]

Date February 19, 2006

REGISTRATION NO. 41,827

(if appropriate)

Docket Number: 26006

Respectfully submitted,

SIGNATURE

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This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop Provisional Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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Docket Number 26006

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[Page 2 of 2]

Number 2 of 2

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MAIL STOP PROVISIONAL PATENT APPLICATION  
Attorney Docket No. 26006

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

BERCOVIER et al.

Serial No. NOT YET ASSIGNED

Filed: February 19, 2004

For: A PHARMACEUTICAL COMPOSITION AND METHOD FOR TREATING A DISEASE  
AND A DIAGNOSTIC TOOL THEREFOR

TRANSMITTAL LETTER

Commissioner for Patents  
P.O. Box 14506  
Alexandria, VA 22313-1450

Sir:

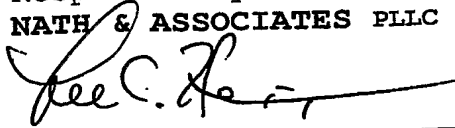
Submitted herewith for filing in the U.S. Patent and Trademark Office is the following **PROVISIONAL APPLICATION**:

- (1) Transmittal Letter
- (2) Cover sheet for filing **Provisional Application**
- (3) 17 page Provisional Application consisting of:
  - 14 pages Textual Specification,
  - 0 pages of Claims,
  - 0 page of the Abstract,
  - 3 sheets of Drawings;
- (4) Check No. 20442 \$ 80.00 for filing fee as a small entity;
- (5) Postcard for early notification of serial number.

The Commissioner is hereby authorized to charge any deficiency or credit any excess to Deposit Account No. 14-0112.

Respectfully submitted,  
**NATH & ASSOCIATES PLLC**

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A PHARMACEUTICAL COMPOSITION AND METHOD FOR  
TREATING A DISEASE AND A DIAGNOSTIC TOOL THEREFOR

FIELD OF THE INVENTION

This invention relates to the diagnosis and treatment of diseases and disorders with a unique amino acid molecule, and in particular, to treatment of tuberculosis.

5 BACKGROUND OF THE INVENTION

Tuberculosis (TB) is mostly a pulmonary lung disease caused by *Mycobacterium tuberculosis* (*Mtb*). This organism is a slow-growing bacillus that is transmitted by the respiratory route. Soon after infection, the bacilli are phagocytosed by alveolar macrophages and survive within early phagosomes.  
10 Innate immune responses directed by macrophages predominate early in infection. Subsequent recruitment of dendritic cells leads to cell-mediated responses involving CD4<sup>+</sup> and CD8<sup>+</sup> T cells and eventual granuloma formation. Among infectious diseases, tuberculosis remains the second leading killer of adults in the world, with more than 2 million TB-related deaths each year (CDC  
15 2004). The vast majority of immunocompetent individuals are able to contain, but not eliminate, the pathogen in pulmonary granulomas, leading to latent tuberculosis infection a small minority of cases, through unclear mechanisms, persistent bacilli can reactivate to form disease many years to decades after initial infection.

20 Virulent *Mycobacterium* cell wall-associated lipids

A major cell surface component of *Mtb* and other virulent *mycobacterium* sp. is the polysaccharide manosylated lipoarabinomannan (manLAM). ManLAM

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is a phosphatidylinositol-anchored lipoglycan composed of a mannan core with oligoarabinosyl-containing side-chains with diverse biological activities. This polysaccharide accounts for up to 5 mg g<sup>-1</sup> bacterial weight. ManLAM structure differs according to mycobacterial species, and three general classes of manLAM  
5 have been described: (i) ManLAM, from the virulent strains Erdman and H37Rv and the avirulent strains H37Ra and BCG [Chatterjee, D., et al. J Biol Chem 267: 6234-6239 (1992); Prinzi, S., et al. J Gen Microbiol 139: 2649-2658 (1993)], which is characterized by extensive mannose capping of the arabinan termini; (ii) phospho-myo-inositol-capped manLAM (PILAM), found in the rapidly growing  
10 mycobacteria *M. smegmatis* and *M. fortuitum* [Nigou, J. Biochimie 85: 153-166 (2003)]; and (iii) AraLAM, which was described in the rapidly growing *M. chelonae* and lacks mannosylation in its arabinan termini [Guerardel, Y., et al. J Biol Chem 277: 30635-30648 (2002)]. Although there is significant heterogeneity between manLAM molecules with respect to glycosylation and  
15 acylation [Nigou et al. (2003) *ibid.*], differences in biological activity between the major classes of manLAM have been attributed primarily to the heavy mannose capping of ManLAM or to differences in the phosphatidylinositol anchor [Chatterjee et al. (1992). *Ibid.*]

In several publications it has been shown that sera of TB patients contain  
20 higher levels of anti-manLAM antibodies than that of healthy individuals [Hetland G, et al. Clin Diagn Lab Immunol. 5(2):211-8 (1998)]. Consequently it has been suggested to be one of the candidate antigens for rapid diagnosis of TB [Antunes A, et al. Res Microbiol. 153(5):301-5 (2002)].

#### DESCRIPTION OF THE INVENTION

25 In the description herein, the following abbreviations are used, all acceptable in the art:

*Mtb* - *Mycobacterium tuberculosis*

TB - Tuberculosis

TBS - tris buffer saline

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- PBS – phosphate buffer saline  
manLAM- Mannosilated Lipoarabinomannan  
Ab- Antibodies  
mAb – Monoclonal Ab  
5 Ag- Antigen  
Hr -Hours  
ELISA- Enzyme-linked immunosorbent assay  
RT- Room temperature  
Aa –Amino acid  
10 BSA- Bovine Sera Albumin  
KLH - keyhole limpet hemocyanin  
IFA - incomplete freund's adjuvant  
DDA - dimethyldioctadecylammonium bromide  
SPF - Specific pathogen-free  
15 IP- intra peritoneal  
SC – subcutaneous  
FACS - flow cytometry

The present invention is based on the finding of a unique peptide which  
20 acts as a manLAM mimotope. This peptide, having the amino acid sequence:  
ISLTEWSMWYRH (SEQ ID NO:1) was shown to have the following  
characteristics:

1. It binds competitively to a manLAM binding monoclonal antibody  
(mAb).
- 25 2. When vaccinating with the peptide cross-reactive anti manLAM  
antibodies are elicited.
3. Sera tested from TB patients (16/16) and Mtb infected mice (10/10)  
has significant levels of antibodies that bind the mimotope peptide.

Thus, according to one of its aspects, the present invention provides a  
30 pharmaceutical composition (e.g. a vaccine) comprising a pharmaceutically

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acceptable carrier and as an active ingredient an amino acid molecule comprising the sequence selected from:

- (a) the amino acid sequence ISLTEWSMWYRH (SEQ ID NO:1)
- (b) a biologically functional analog of the amino acid sequence of (a).

5 The "*Amino acid sequence*" according to the invention is a sequence composed of any one of the 20 naturally appearing amino acids, amino acids which have been chemically modified or synthetic amino acids

The term "*biologically functional analog*" refers to any peptide comprising a region which when optimally aligned with the sequence of (a) has  
10 at least 90% homology with the latter.

"*Optimally alignment*" is defined as an alignment giving the highest percent identity score

The variation in amino acid sequence between the homologue and the sequence of SEQ ID NO:1 or a fragment thereof, arises from the addition,  
15 deletion, or substitution or chemical modification of one or more amino acids of the sequence of SEQ ID NO:1. Where the homologue contains a substitution, the substitution is preferably a conservative one.

"*Conservative substitution*" as used herein refers to the substitution of an amino acid in one class by an amino acid of the same class, where a class is  
20 defined by common physicochemical amino acid side chain properties and high substitution frequencies in homologous proteins found in nature, as determined, for example, by a standard Dayhoff frequency exchange matrix or BLOSUM matrix. Six general classes of amino acid side chains have been categorized and include: Class I (Cys); Class II (Ser, Thr, Pro, Ala, Gly); Class III (Asn, Asp,  
25 Gln, Glu); Class IV (His, Arg, Lys); Class V (Ile, Leu, Val, Met); and Class VI (Phe, Tyr, Z= I Trp). For example, substitution of an Asp for another class III residue such as Asn, Gln, or Glu, is a conservative substitution.

"*Non-conservative substitution*" refers to the substitution of an amino acid in one class with an amino acid from another class; for example, substitution

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of an Ala. a class 11 residue, with a class III residue such as Asp, Asn, Glu. or Gln.

"*Deletion*" is a change in amino acid sequence in which one or more amino acid residues is absent as compared to the original sequence having  
5 designated as SEQ ID NO:1.

"*Insertion*" or "*addition*" as used herein denotes a change in an amino acid sequence which has resulted in the addition of one or more amino acid residues as compared to the original sequence having designated as SEQ ID  
NO:1

10 "*Substitution*" as used herein denotes replacement of one or more amino acids by different amino acids as compared to the original sequence having designated as SEQ ID NO:1. The substitution may be conservative or non-conservative, however, is preferably a conservative one.

The term "*pharmaceutically acceptable carrier*" refers to any vehicle,  
15 adjuvant, excipient, diluent, which is known in the field of pharmacology for administration to a human subject and is approved for such administration. The choice of carrier will be determined by the particular active agent, for example, its dissolution in that specific carrier (hydrophilic/hydrophobic), as well as by other criteria such as the mode of administration. One specific example is a  
20 vaccine comprising the peptide as defined and a pharmaceutically acceptable carrier suitable for injection.

The pharmaceutical composition according to the invention is preferably for the treatment or prevention of a disease, disorder or pathological condition.

According to one preferred aspect of the invention, the disease is and  
25 infectious disease and preferably, a microbacterial caused disease. Most preferably, the disease is Tuberculosis (TB).

The term "*treatment or prevention*" as used herein refers to the administration of a therapeutic amount of the active agent according to the

invention which is effective in one of the following: ameliorating undesired symptoms associated with a disease, disorder, or pathological condition. For example, in case of TB the symptoms may be coughing, dyspnea, pleural effusion; effective in preventing the manifestation of such symptoms before they occur; effective in slowing down the progression of a disease or disorder; effective in slowing down the deterioration of the disease (for example, in case of TB, to prevent the development of pleural TB or tuberculous empyema and bronchopleural fistula) in restricting the spreading of psoriasis to healthy region); effective to prolong the time period onset of remission period; effective in slowing down the irreversible damage caused in a progressive chronic stage of a disorder; effective to delay the onset of said progressive; effective to lessen the severity or cure the disease or disorder; effective to improve survival rates of individuals infected with the disease, or effective to prevent the disease form occurring altogether (for example in an individual generally prone to the disease) or a combination of two or more of the above.

According to another aspect, the invention concerns a method of treatment of a subject in need, the method comprises providing said subject with a therapeutically effective amount of an amino acid molecule comprising a sequence selected from:

- 20 (a) the amino acid sequence **ISLTEWSMWYRH (SEQ ID NO:1)**
- (b) a biologically functional analog of the amino acid sequence of (a).

According to yet another aspect of the invention there is provided the use of an amino acid molecule for the preparation of a pharmaceutical composition, the amino acid molecule comprising a sequence selected from:

- 25 (a) the amino acid sequence **ISLTEWSMWYRH (SEQ ID NO:1)**
- (b) a biologically functional analog of the amino acid sequence of (a).

Yet further, the present invention concerns a diagnostic kit comprising a composition comprising:

- (i) an amino acid molecule comprising the sequence selected from:

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- (a) the amino acid sequence ISLTEWSMWYRH (SEQ ID NO:1)
  - (b) a biologically functional analog of the amino acid sequence of (a); and
- 5 (ii) instructions for use of said composition in diagnosis of a disease in a subject susceptible of carrying the disease or in diagnosis the severity of a disease in a subject diagnosed for carrying the disease.

The kit of the invention may be used in various ways, e.g. in combination with ELISA or in combination a solid phase technology such as dot blot where  
10 the peptide is bound to a solid phase and used to analyze sera from subject suspected of carrying a disease, such as TB. The Ab titers are then determined by a secondary anti-human antibody.

#### BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out  
15 in practice, a preferred embodiment will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

**Fig. 1** is a bar graph showing the ability of CS40 linear peptide recombinant phage to induce production of cross reactive Ab that bind manLAM in mice immunized with CS40 linear peptide recombinant phage, as compared to  
20 mice vaccinated with control phage or control naïve mice.

**Fig. 2** is a graph showing the competitive binding of CS40 linear peptide to manLAM antibodies.

**Fig. 3** is a bar graph showing level of titer of anti CS40 linear peptide when being conjugated to keyhole limpet hemocyanin (KLH) via Cystein and  
25 emulsified in the MPL<sup>®</sup> + TDM Adjuvant system, as compared to pre-immune or naïve mice, or mice treated with KLH-TDM.

**Fig. 4** is a bar graph showing level of titer of anti CS40 linear peptide after 30 days or 3 months as compared to naïve mice.

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Fig. 5 is a bar graph showing level of titers of anti manLAM and anti CS40 linear peptide in sera of tuberculosis patients (Mtb patients) compared to healthy subjects (negative control) and vaccinated subjects (vaccinated).

Fig 6A-6B are FACS analysis diagrams showing the binding of CS40 linear peptide FITC conjugated to 50% of cells of the RAW 264.7 cell line (Figure 6A), and wherein the presence of 0.125 D-mannose the binding of the FITC conjugated peptide is reduced to 18% (Figure 6B).

## DESCRIPTION OF THE SPECIFIC EXAMPLES

### MATERIALS AND METHODS

#### 10 Biopanning

Biopanning was performed based on Smith and Scott 1993, briefly 6 well polystyrene plates were coated with mAbs 5µg/well in Tris buffer saline (TBS), and then blocked with TBS/0.25% gelatin for 2hr RT.  $10^{11}$  phages in TBS/0.25% gelatin were bound to the Ab at 4°C for 16hr the unbound phages were washed in 4 times in TBS and the bound phages were eluted with glycine-HCL/BSA pH 2.2 for 10m and neutralized with tris buffer pH 9.1.

Determination of clones binding the mAbs was performed by dot blot and manLAM was used as a positive binding control. Second and third rounds of biopanning were performed if no binding clones were found.

20 Anti manLAM antibodies and manosylated lipoarabinomannan (manLAM) were provided By Drs. Patrick Brennan and John Belsile (Colorado State University, Fort Collins, CO; National Institute of Health grant AI-75320)

#### Enzyme-linked immunosorbent assay (ELISA)

In general the assay was performed by coating 96 well Nunc Immuno™ maxisorp plates with 50µl of the relevant Ag. The plates were washed twice in phosphate buffer saline (PBS) and blocked with 1% BSA in PBS then washed twice and 50µl/well of mAb/Sera were added and incubated for 1 hour at 37°C. After washing, alkaline phosphatase-labeled goat anti-mouse immunoglobulin (Sigma Cat# A-1902) was added. Following a 90-min incubation at 37°C, *p*-01521640\4-01

nitrophenyl phosphate (KPL Cat # 50-80-00) was added to the plates and optical density was measured at 405 nm (Shin et al 2001).

#### **Concentration of Ab, sera and Ags**

For direct phage ELISA wells were coated with  $10^9$  phage particles per 5 well in TBS.

When peptide ELISA was performed wells were coated with 10  $\mu$ g peptide per well in PBS. manLAM (50  $\mu$ g/ml) was used to coat wells of immulon® 4HBX plates.

For analysis of mouse sera the sera were diluted 1/50 in PBS, mAb was 10 used at 5 $\mu$ g/well.

Assays using human sera were performed according to Navoa et al 2003.

Competitive ELISA was performed according to Kaur 2002.

#### **Peptide synthesis**

Peptide sequence ISLTEWSMWYRH was synthesized by solid phase by 15 Prof. Matti Fridkin at the Weitzman institute Rehovot, Israel, and by Mrs Lilian Glazer at the Hadassah Medical School, Jerusalem, Israel.

#### **Immunization**

For immunization, peptide was conjugated to keyhole limpet hemocyanin (KLH) via cysteine at the peptide amino terminus. 2mg of peptide were 20 conjugated to the KLH according to manufactures instructions (Pierce Cat# 77606).

Specific pathogen-free (SPF) female BALB/c mice, 5–8 weeks old, were injected with 5 $\mu$ g or 50  $\mu$ g conjugated peptide intra peritoneal (ip) or subcutaneously (sc) and boosted with the same dose three weeks from immunization. Various 25 adjuvants were tested as following; peptide conjugate was emulsified in MPL® + TDM Adjuvant system (sigma Cat. # M-6536), in incomplete freund's adjuvant (IFA) (sigma Cat # F-5506) both according to manufactures instruction and in

dimethyldioctadecylammonium bromide (DDA) (Fluka, Switzerland. Control groups were immunized with the adjuvant only.

FITC binding and flow cytometry (FACS) analysis 50µg of peptide were conjugated to FITC as described by Sethi et al. [Sethi et al. Cell Motil  
5 Cytoskeleton. 52(4):231-41 (2002)]. Cell line RAW 264.7 American Type Culture Collection (ATCC) was grown in complete Dulbecco's modified Eagle's medium (Biological industries, Beit Haemek) to a 80% confluent culture. For binding assay cells were washed three times in cold PBS and harvested from flask. Cells were then incubated with FITC conjugated peptide for 15 minutes at  
10 37°C centrifuged at 3000rpm 4°C washed 3 time in cold PBS. The fluorescence levels were determined by FACS analysis. Competitive binding of mannose was performed according to Nguyem and Hildreth [Nguyen DG, Hildreth JE. Eur J Immunol. 33(2):483-93 (2003)].

## RESULTS

### 15 **Finding manLAM mimotope and specific binding determination**

In a search for a manLAM mimotope, random phage display libraries with mAbs were screened. As a result, a linear 12 amino acid peptide that mimics manLAM (mimotope) was found. In particular, screening was performed using mAb CS40, and a clone presenting a linear 12 amino acid sequence  
20 ISLTEWSMWYRH was found.

Testing the binding of the positive phage clone to the CS40 antibody was performed by Dot-Blot and ELISA essays. To further test the recombinant phages' affinity to the antibody, competitive ELISA was performed. The phage clone showed the ability to compete with the binding of the Ab to the manLAM.

### 25 **Immunization with phage clone CS40 linear mimotope**

To test the ability of CS40 linear mimotope recombinant phage to induce production of cross reactive Ab that bind manLAM, 5 mice were immunized with  $10^{12}$  phages and boosted two weeks after first injection. The sera were pooled and tested by ELISA for anti manLAM IgG Ab. As control, sera from

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naïve mice as well as mice vaccinated with control phage were tested. The mice vaccinated with the CS40 linear mimotope had specific cross reactive anti manLAM IgG Antibodies (Figure 1).

#### **Testing the binding properties of the peptide mimotope**

5 A peptide corresponding to the CS40 mimotope phage clone was synthesized. The binding of the synthetic peptide to CS40 mAb was tested by direct ELISA and by competitive ELISA. It was shown that the synthetic peptide mimics a manLAM epitope; the Ab bound the peptide in direct ELISA assay and showed an ability to compete with the binding of the Ab to manLAM (figure 2).

#### **10 Immunization with the peptide mimotope**

To test if the peptide elicits the production of Ab cross reactive to manLAM Balb/c mice were vaccinated with the synthetic CS40 linear peptide mimotope in various routs of administration and adjuvants.

15 It was found that the peptide preparation that elicited cross reactive Ab was the mimotope conjugated to keyhole limpet hemocyanin (KLH) via Cystein and emulsified in the MPL<sup>®</sup> + TDM Adjuvant system. Specifically, each mouse received 50 µg of peptide per injection of this formula. The results shown in Figure 3 suggest that the peptide mimotope is a potential vaccine candidate for tuberculosis.

#### **20 *Mtb* Infected mice produce anti peptide mimotope Ab**

Thirty days (n=6) and three months (n=4) after *Mtb* infection Balb/c mice were tested for IgG anti manLAM and anti CS40 linear mimotope Abs, and were compared to naive mice (n=6).

25 The *Mtb* infected mice showed both anti manLAM and anti CS40 linear mimotope Ab. The Ab levels of the anti manLAM and anti mimotope in the mice were similar; however, the standard deviation between the mice in the case of mimotope was lower. Figure 4 shows the Ab level of anti-manLAM and anti-mimotope in the three tested groups (30 days, 3 months and naïve mice)



**IgG anti CS40 linear peptide antibodies in human tuberculosis patients**

Significantly higher titers of anti manLAM and anti CS40 linear peptide exist in sera of tuberculosis patients (n=16) compared to healthy people (n=36). As in the case of mice sera the human Ab levels of the anti manLAM and anti  
5 mimotope are similar but the variability (standard deviation) in the case of the mimotope was lower. This gives indication that the peptide can be a more reliable diagnostic tool than manLAM. Sera from BCG vaccinated people (n=10) were tested and the Ab titers shown were significantly lower than in TB patients and higher than in the healthy non vaccinated patients (Figure 5). This may thus  
10 serve as a tool to differentiate vaccinated between sick and healthy subjects.

**CS40 linear peptides binds macrophage cell line RAW 264.7**

CS40 linear peptide FITC conjugate was found to bind to Macrophage cell line RAW 264.7(Figure 6A). This binding was inhibited by D-mannose (Figure 6B).

15

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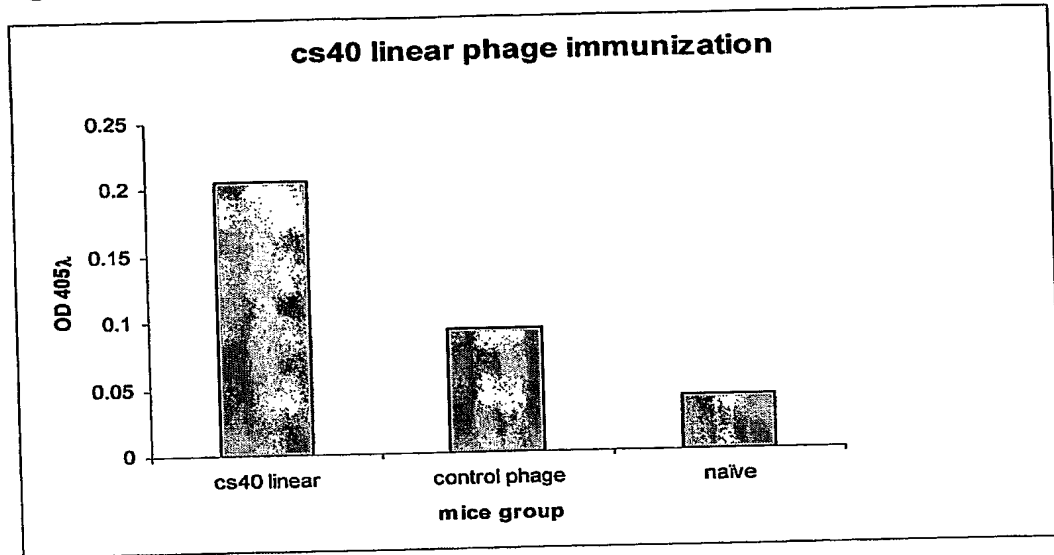
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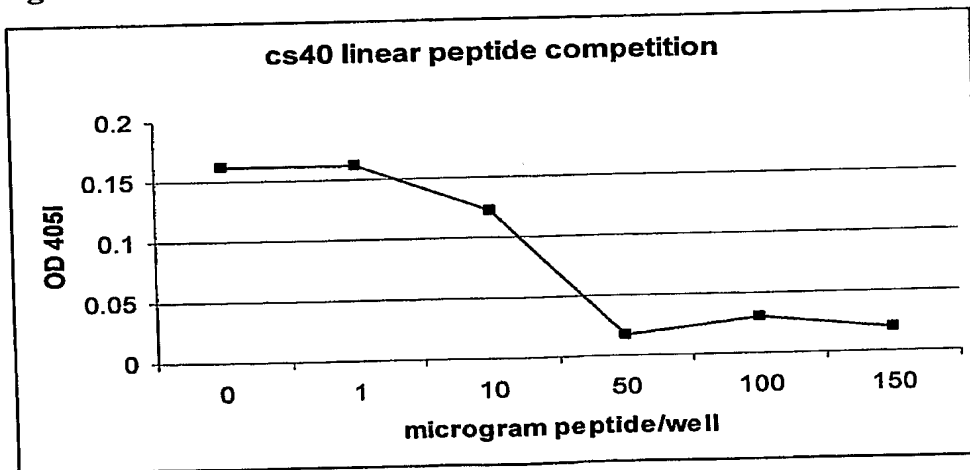
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Figure 1:



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Figure 2:



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Figure 3:

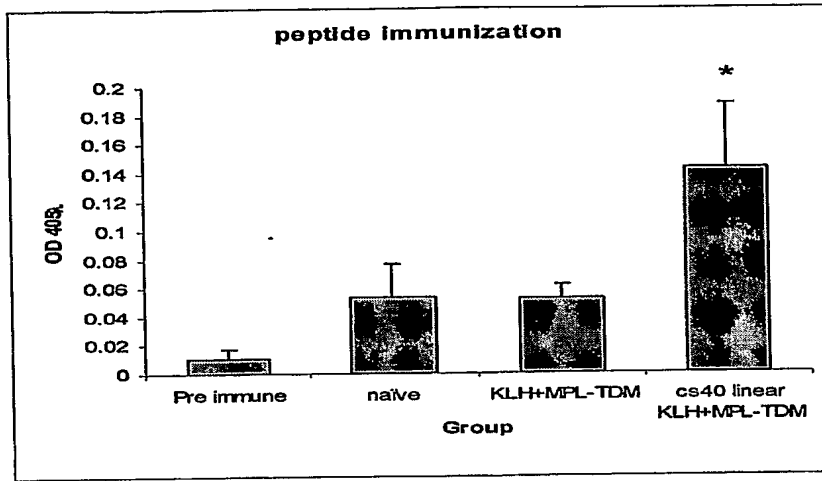
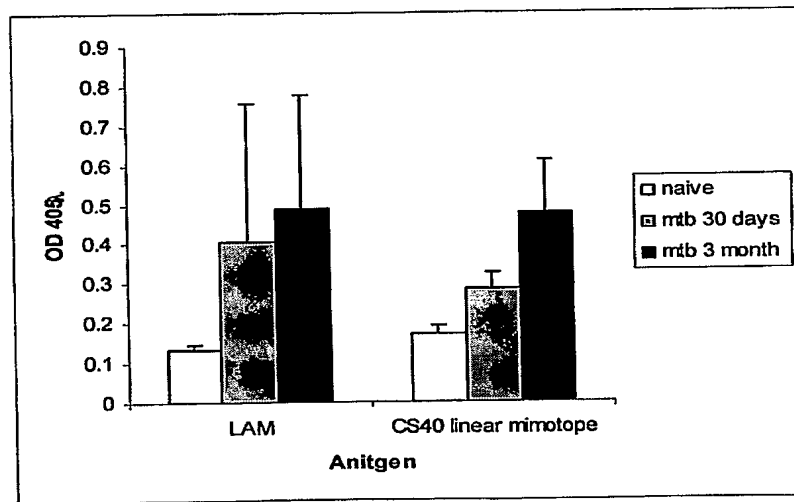


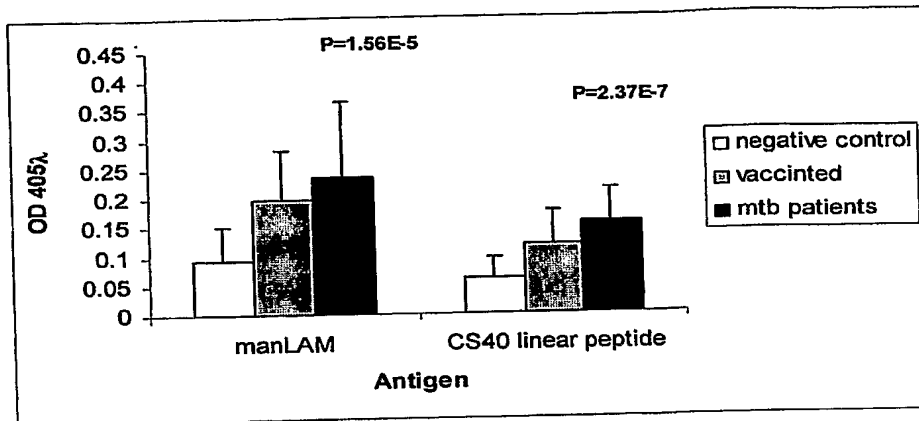
Figure 4:



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Figure 5:



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Figure 6A

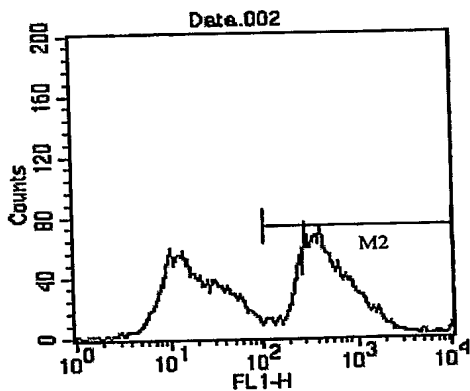
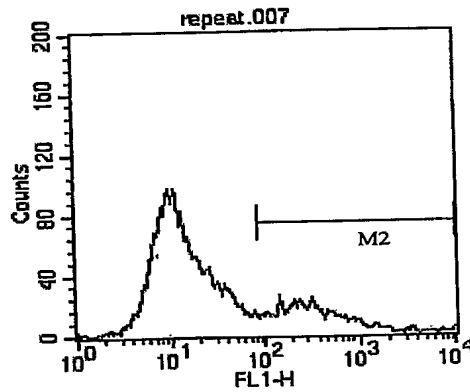


Figure 6B



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